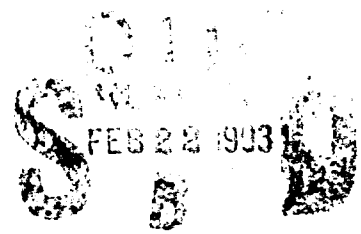
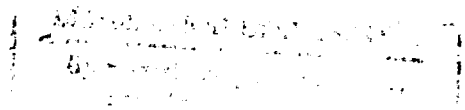
(2)

A RAND NOTE

Elements of Change in Military Medical Force Structure: A White Paper

William Michael Hix, Susan Hosek





RAND

The research described in this report was sponsored by the Assistant Secretary of Defense (Force Management and Personnel), Assistant Secretary of Defense (Reserve Affairs), and the Assistant Secretary of Defense (Program Analysis and Evaluation) under RAND's National Defense Research Institute, a federally funded research and development center supported by the Office of the Secretary of Defense and the Joint Staff, Contract No. MDA903-90-C-0004. Review of the material does not imply Department of Defense endorsement of factual accuracy or opinion, particularly on the current size and structure of U.S. military medical forces.

Published 1992 by RAND
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407-2138

A RAND NOTE

N-3272-FMP/RA/PA&E

Elements of Change in Military Medical Force Structure: A White Paper

William Michael Hix, Susan Hosek

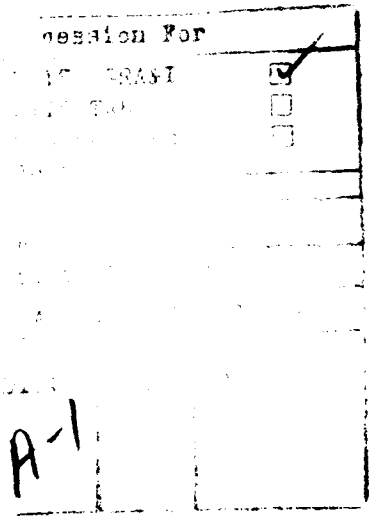
Prepared for the
Assistant Secretary of Defense
(Force Management and Personnel)
Assistant Secretary of Defense
(Reserve Affairs)
Assistant Secretary of Defense
(Program Analysis and Evaluation)

RAND

PREFACE

This "white paper" was prepared in response to a request by the Department of Defense Total Force Policy Study to review the missions and functions of military health care and how those missions are translated into active and reserve medical force structure requirements. The objective was to describe how the determinants of these force structure requirements may change and what policy options are available to the Department of Defense for sizing the active and reserve medical force. Sections of the paper evolved from earlier work by Vance Gordon, a RAND consultant.

The paper was prepared as part of a larger project to assist the Total Force Policy Study. The project was sponsored by the Assistant Secretary of Defense (Force Management and Personnel), the Assistant Secretary of Defense (Reserve Affairs), and the Assistant Secretary of Defense (Program Analysis and Evaluation). The research was conducted within the Defense Manpower Research Center of RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense and the Joint Staff.



SUMMARY

The Defense Department maintains a substantial health care delivery capability for two distinct but related reasons. First, as with its other support functions, the department needs a medical capability to support its ability to go to war. This mission, often called the "readiness mission" of the military health care establishment, requires the Department to maintain the medical readiness of its uniformed personnel both in peacetime and during hostilities. In time of war, the readiness mission takes on the added dimension of care of casualties.

Transportation, maintenance, supply, training, and most other support functions serve a similar readiness mission. In fact, these capabilities exist solely to enhance the readiness of the Department. But the medical function serves a second, perhaps equally important, function. The health care the medical establishment provides service members, including retirees, and their families represents an important compensation benefit. In fact, the health benefit stands second only to retirement in value, and therefore in importance, to service members and their families. To attract and retain employees in today's competitive marketplace, every employer must offer its employees a health benefit, and the Defense Department is no different. This second mission is often referred to as the "benefit mission."

The conflict in these two missions makes the military medical function tricky to size. The readiness mission requires the Department to maintain an active duty medical establishment that is also able to deliver health services in support of the benefit mission. Even reservists needed in wartime can, during their annual and weekend active duty training periods, assist in delivering health benefits to service members. But the readiness mission requires a different mix of resources than that required to accomplish the benefit mission. The readiness mission dictates a large number of surgeons and related specialists, and a large number of deployable hospitals for use in theaters of operations; in addition, military and civilian facilities are needed in the United States for service members located there and for evacuated casualties. The benefit mission, on the other hand, is better served by a force with more pediatricians, obstetricians, and other specialists not in such great demand for the readiness mission. Further, the benefit mission is best served by fixed hospitals and clinics on the various military bases in the United States and overseas. The situation is made more complex in that the benefit mission continues once a war

begins. Provisions must be made for the continued care of service members' dependents once the troops go off to war.

The military medical function costs about $13 billion a year and employs about 329,000 military and civilian personnel. An establishment of such magnitude deserves careful attention to ensure that it is sized and structured efficiently.

With the recent changes in the Soviet Union and the collapse of the Warsaw Pact, the Defense Department faces a declining threat. Accordingly, the Department plans to cut the size of the armed forces substantially over the next five years. At issue is how the medical function should share in those cuts. Clearly, as threats and planning scenarios change, medical requirements to support the readiness mission will change. As the size of the peacetime active duty force declines, so will the demands of the benefit mission.

The most fundamental planning factors underlying the readiness mission can be expected to vary dramatically from those assumed before the European threat began to decay. Relative to recent European scenarios, future planning scenarios are likely to be based on smaller populations at risk, lower casualty rates, different assumptions about which casualties are treated in theater and in the United States, and which of the patients evacuated to the United States are to be treated in military and civilian hospitals. Together, these planning factors determine much of the size of the medical establishment required to support the readiness mission. In the present world of changing scenarios, the Defense Department would benefit from a thorough analysis of these planning factors and their implications for medical requirements. Included in this analysis should be an assessment of reserve component and civilian options for meeting those requirements.

With regard to sizing for the benefit mission, several issues arise. The Department has open to it two broad means of providing the health benefit. It may provide that care in kind through hospitals and clinics it owns and operates or it may simply provide the financial means for such care, as most employers do. The argument for providing care directly is based largely on cost. Medical personnel and facilities that must be bought for the readiness mission are able to contribute to the benefit mission as well. Hence, it is argued, the marginal cost of accomplishing the benefit mission in direct care facilities is lower than accomplishing it by buying the care outside. However, this marginal cost argument has never been demonstrated rigorously. To do so is a difficult undertaking and the outcome is not certain.

- Current cost data are incomplete;
- The mix of resources needed to fulfill the readiness mission does not match that required to accomplish the benefit mission, so resources must be added;
- As direct care facilities are expanded, beneficiaries who were being treated under non-DoD plans may present themselves for treatment at military facilities and beneficiaries who already use the DoD system may increase their levels of use, both of these increasing costs; and
- DoD is testing new ideas for coordinating military and civilian resources, confounding cost analysis.

Of central importance to any evaluation of the medical force structure is graduate medical education (GME). Graduate medical education for military physicians is conducted in military and civilian hospitals. The Army, Navy, and Air Force train very different proportions of their physicians in military hospitals; all choose to train some there. In-house GME programs require large tertiary care hospitals such as Walter Reed, Bethesda, and Wilford Hall. Tertiary care hospitals are needed to provide complex care in a large medical system and to employ wartime-required surgical subspecialists; however, the number and size of these hospitals are also heavily influenced by the size of the GME programs. The number and size of those large facilities in turn determine the patient population that must be referred from the smaller hospitals around the world. Any review of the changing requirements for the medical force structure should include a careful evaluation of the size of GME programs. The private sector offers options to serve both the readiness and the benefit missions. Current planning assumes that wounded and sick patients evacuated to the United States will be treated in civilian as well as military facilities. Retirees, dependents, and even to some extent active duty personnel are treated in civilian facilities during peacetime. The question is to what extent should DoD take advantage of civilian options in planning for an altered future.

Because the readiness and benefit missions are not perfectly matched, no medical force structure will ideally serve either mission; there must be tradeoffs. Fundamental to the DoD missions, however, is the readiness mission; it should serve as the basis for building both the active and reserve force structure. As the wartime-

required force declines in size, so will the amount of care it can provide to peacetime beneficiaries.

DoD needs a thorough quantitative analysis of the size and structure of military medicine. The analysis should simultaneously evaluate a broad range of issues, including: (1) wartime requirements evacuation policy, based upon the new planning scenarios that are being developed and a reassessment of evacuation policy, (2) CONUS retention policy, (3) the marginal cost of providing non-active duty care in medical treatment facilities (MTFs), and (4) the size of GME programs. Important considerations such as airlift requirements, overall manpower restrictions, budget constraints, roles and missions, and pay and benefits extend the scope of the issue and require broad DoD participation in evaluating these issues.

ACKNOWLEDGMENTS

We appreciate the support and guidance we received in writing this paper from the staff of the Total Force Policy Study and, in particular, its Executive Director, Frank Tapparo. We also would like to thank our RAND colleagues Bernie Rostker and John Winkler for their helpful comments on an earlier draft.

CONTENTS

1. INTRODUCTION

As the nation faces a new international order, new and different hostile threats, and reduced resources for national defense, the military health care system faces a reassessment of its dual missions of, first, providing care for casualties in wartime and, second, providing benefits to dependents and retirees, as well as active duty personnel, in peacetime. Meeting these missions consumes large amounts of resources—290,000 people and $13 billion a year. The purpose of this Note is to provide an understanding of the missions and functions of military health care and how those missions and functions are translated into resource requirements for the active and reserve components of the Department of Defense (DoD). The discussion is offered in the context of: (1) how requirements for medical resources are likely to change in the future and (2) what policy options are available to size the active and reserve medical force.

MILITARY HEALTH CARE TODAY

Nowhere in the defense budget does one find a full accounting of the total cost of military health care, but the function clearly represents a sizeable demand on the resources allocated to DoD. Its cost has been estimated to exceed $13 billion.[1]

DoD directly operates over 800 hospitals and medical clinics throughout the world. This number includes 168 hospitals, 18 of which serve as teaching centers. On an average day, one would find about 12,200 of the 15,300 beds occupied.[2] In addition to these fixed facilities, the Department maintains a substantial field medical capability designed to serve our forces in wartime.

In terms of manpower, DoD devotes over 300,000 personnel to the medical function, as shown in Table 1.[3] These figures include personnel in traditional hospital and clinic settings, as well as those in combat units, shipboard sickbays,

---

[1]U.S. Department of Defense, Office of the Assistant Secretary of Defense for Health Affairs, *Report to the Congress on the Reorganization of Military Health Care*, June 1990; Statement of the Assistant Secretary of Defense for Health Affairs before the Senate Armed Services Subcommittee on Manpower and Personnel, May 15, 1990, p. 1.

[2]U.S. Department of Defense, Defense Medical Systems Support Center, *Selected Medical Care Statistics*, September 30, 1989, p. 23.

[3]U.S. Department of Defense, *Manpower Requirements Report, FY1991*, Medical Manpower Annex, February 1990, p. 4.

aeromedical evacuation squadrons, headquarters activities, medical recruiting, and health care education and training.

In addition to the roughly $10 billion a year devoted to the in-house medical structure, DoD spends more than $3 billion a year to reimburse non-DoD providers for care rendered to retirees and dependents under a program called CHAMPUS.[4] On an average day in FY1989, about 5,600 dependents and retirees are hospitalized in U.S. civilian facilities under the CHAMPUS program.[5] This number is slightly less than half the 12,200 patients hospitalized in military facilities worldwide on a given day.

Table 1

Medical Manpower
(thousands)

Type of Manpower	Active	Reserve	Total
Officer	46.7	35.9	82.6
Enlisted	108.3	85.6	193.9
Civilian	52.7	—	52.7
Total	207.7	121.5	329.2

SOURCE: U.S. Department of Defense, *Military Manpower Requirements Report, FY 1991*, Medical Annex, February 1990, p. 4.

MOTIVATION

Section 1101 of the National Defense Authorization Act for Fiscal Years 1990 and 1991 required DoD to review its total force policy—the policy of the United States to rely on a mix of active and reserve personnel to achieve national security goals. In response to the congressional mandate, the Department created the Total Force Policy Study Group under the Assistant Secretaries of Defense for Force Management and Personnel and Reserve Affairs. As the Authorization Act required, the study group paid special attention to "the operation, effectiveness, and soundness of the Total Force Policy; the assignment of missions within and between the active and reserve components; (and) the structure of U.S. active and reserve forces..."[6]

---

[4]Civilian Health and Medical Program of the Uniformed Services.

[5]Lloyd Dixon, et al., *Utilization and Costs in the CHAMPUS Reform Initiative: Preliminary Results for April–September 1989*, RAND, N-3243-HA, 1991, p. 24.

[6]U.S. Department of Defense, *Total Force Policy Report to the Congress*, December 1990, p. i.

The study group asked RAND to prepare this white paper on the medical function. The size of the military medical force structure, the high proportion of that force structure that lies in the reserves, and the options offered by our large civilian medical capacity in the United States make the medical function a significant component in any analysis of the total force.

ORGANIZATION

The Note begins with a description of the two missions of the military health care system and DoD's policy for sizing the system to meet those missions. Section 3 discusses the determinants of the size of the wartime-required force. Section 4 provides a similar analysis of the size of the force required for the peacetime benefit mission. Finally, Sec. 5 briefly discusses sizing the force for both missions and the need for further analysis of medical resource levels.

2. THE MISSIONS AND THE SIZE OF THE MILITARY HEALTH CARE SYSTEM

The law requires DoD to accomplish two primary missions with regard to health services.[7] They are: (1) to maintain the peacetime health of the active duty force and be prepared to attend the sick and wounded in time of war, and (2) to provide a health benefit as a condition of service to eligible beneficiaries.

The first, the so-called "readiness mission," implies a medical support structure both overseas and in the United States tailored to maintain the physical readiness of our forces in peacetime and to care for them during hostilities.

Overseas, the health care demands of our forces, both in peacetime and in wartime, are most appropriately met through in-house medical facilities. In theaters of operations with highly developed health care systems, such as in Western Europe, there may be limited opportunities to rely on resources external to DoD, but it is reasonable that the entire overseas workload should be accommodated using in-house medical facilities, medical manpower (both active and reserve), and other DoD medical resources.

In the United States, however, alternative means of providing care for active duty personnel do exist, both in peacetime and in wartime, and are in fact employed. In peacetime, civilian emergency services and specialty care not readily available in-house are provided routinely to active duty patients, although the services strive to strictly limit such care for reasons of cost and control of patients. DoD has also long planned that the long-term care of many wartime casualties evacuated to the continental United States (CONUS) would be provided by nonmilitary hospitals, including Veteran Administration hospitals and civilian hospitals participating in the National Disaster Medical System. As an option, further use of civilian facilities might be considered.

The second medical mission, assigned by law, is to provide for the medical needs of retirees and all dependents, in order to "create high morale in the uniformed services." This mission may be termed the "benefit mission" and is a form of compensation since it would be difficult to attract and retain service members without offering them and their families a medical benefit that is competitive with that offered by other employers.

---

[7] 10 U.S.C. 3062, 5012, 5013, and 8062 assign the readiness mission. 10 U.S.C., Chapter 55 assigns the benefit mission.

Unlike the readiness mission, the benefit mission by itself does not *necessarily* imply a military medical structure. DoD could meet the mission entirely by paying for such services through a civilian health benefits program similar to the Federal Employees Health Benefits Program. In fact, the law limits any in house structure that may arise from this mission. The services may, but are not required to, add space to existing facilities to accommodate retirees and dependents only under two circumstances: (1) to provide required teaching and training opportunities for health care professionals, or (2) if it can be shown to be more cost-effective to provide care in military hospitals than through any alternative means.

In many ways the two missions complement each other. For example, both missions call for a large number of primary care physicians. Both missions dictate a substantial preventive care emphasis. Further, because much of their cost can be considered sunk, wartime-required hospitals are able to provide peacetime care at lower marginal cost. But regardless of cost, wartime-required hospitals need a patient load in peacetime simply to maintain the technical skills of their personnel.

In other ways the readiness and benefit missions conflict. To the extent that DoD chooses to treat its wartime casualties in CONUS military medical facilities, this aspect of the readiness mission calls for large hospitals, or at least a large number of beds, on our coasts near aerial ports where patients may obtain ready access to services and where aircraft can quickly off-load patients and commence their next mission without delay. However, to directly support the benefit mission, smaller Army and Air Force hospitals should be scattered throughout the nation, where they offer a less-than-optimal solution to the treatment of wartime casualties. More important, perhaps, the two missions also conflict in terms of the mix of resources each implies. Treatment of casualties implies a medical force relatively heavy in the surgical specialties required to treat trauma while the peacetime benefit mission implies proportionately more pediatricians, obstetricians, and other primary care specialists. In these situations, cross-training to provide wartime cross-utilization of specialties can overcome some, but not all, of the specialty mix differences.

DOD SIZING POLICY

The key resource issue in defense health services is how to size the active and reserve component medical services and the DoD's medical facilities. A thorough analysis of the issue represents a complex and substantial undertaking.

The announced DoD policy is to size the medical total force to meet wartime requirements.[8] The concept is to maintain an active duty medical contingent large enough to meet early wartime demands until reserve medical forces are available. In turn, reserves are to be sized to meet demand until draftees become available. Further, the policy is to add resources to the wartime-required active force for graduate medical education or when it can be demonstrated that doing so represents the most cost-effective means of providing peacetime care.

As the following sections demonstrate, the force structure requirements to support the wartime mission are changing in significant ways, and there are ways to rely more on the private sector to support the peacetime benefit mission. As a result, the DoD should reanalyze carefully the size and shape of its medical force structure.

---

[8]The practice has long differed from the announced policy. Despite the stated DoD policy to size the medical structure for wartime requirements, the Department has never built a force structure large enough to meet the requirement. For example, the most recent DoD *Manpower Requirements Report* shows a requirement for 375,000 uniformed medical personnel, active duty and reserve, but only 275,000 in the force.

3. SIZING FOR READINESS

To support the armed forces in wartime, the military departments must maintain an active duty medical force sufficient to keep its peacetime force healthy and to deploy early in overseas contingencies. The services must maintain reserve component medical forces sufficient in size and readiness to augment the early deploying active force. Requirements for wartime medical personnel overseas are scenario specific and depend upon the size and timing of arrival of forces, casualty rates, and policies that relate to the evacuation of patients. All of these factors are changing in fundamental ways as the international order settles out. A far-reaching analysis is required before definitive statements of new medical requirements can be made. Nevertheless, much can be said now about the general magnitude and direction of change.

There are two readiness missions—maintaining the health of the active duty force in peacetime and caring for the sick and injured in wartime. The first is relatively straightforward. Although it may be technically possible to treat some service members in civilian hospitals, the military departments have provided almost all of the care of active duty patients in-house. The reasons for doing so are:

- It would be inefficient to ship the sick and injured to civilian medical facilities for care each day. Loss of duty time for those returned to duty with minor complaints would increase. Further, the use of civilian providers would decrease somewhat the ability of military commanders to monitor members' absence from and fitness for duty.
- It is sound both economically and for training purposes to employ wartime-required providers in peacetime by treating active duty patients, who in fact can occupy only a fraction of the active duty providers required in wartime.

The first reason carries more weight for outpatient than for inpatient treatment; patient control mechanisms for hospitalized service members are simple to devise and inexpensive to staff. The second has merit for both types of care.

The second readiness mission, wartime care, is more demanding. The wartime medical structure is of two types:

- The medical force structure assigned to combat units as a part of the latter's standard organization. For example, included here are the medical personnel assigned to each Army or Marine division, ship, or flying unit. The sizes of these medical u: its remain fairly constant over time because they are based upon fairly stable estimates of historical and prospective medical workload. The organization of these units rarely changes as scenarios change and the units represent only a small proportion of the total medical requirement. Nevertheless, a high proportion of certain specialties resides in these units; for example, many corpsmen and ambulance drivers are assigned to tactical medical units, not to hospitals.
- The hospital, evacuation system, and related structure behind the combat units, including CONUS hospitals. This part of the wartime medical structure represents the overwhelming majority of the total medical resource requirement; most substantive medical care is rendered in the hospitals. The requirements for these hospitals are highly sensitive to assumptions, described below, that affect the medical workload. Hence, this structure is normally referred to as the workload-related requirement.

The remainder of this section focuses on the determinants of workload-based requirements, how they might change in the future, and what implications such changes may have for active and reserve forces. Workload-based requirements depend on four variables:

- Populations at risk and the timing of their exposure,
- The casualty rates experienced by the populations,
- Conversion variables, which govern the translation of that workload into statements of requirements for medical resources, and
- Patient retention and movement policies—those policies that distribute the medical workload in space and time.

When used for planning, all four variables are somewhat uncertain and judgmental. Below, we discuss the complexity and uncertainty surrounding the variables and their interrelationships. We also identify which variables should be analyzed further to help develop policy options in light of changing missions, scenarios, and force levels.

POPULATIONS AT RISK

The populations at risk are the first important determinants of medical resource requirements. They are the most directly tied to the force planning process in DoD. Population-at-risk numbers stem from specific contingency plans developed by the Unified and Specified Commands and the Joint Staff, based upon the specific scenarios and planning approved by the Secretary of Defense. Medical planners, however, require more information about the populations at risk than simple aggregate force levels present in a theater of operations. They incorporate the rates of arrival of units in theater and how those units are to be deployed geographically within the theater. The populations at risk are stratified between the combat zone (the forward battle area) and the communications zone (the area immediately to the rear) and, within each zone, between combat and support forces. The casualty rate to which each unit is expected to be subject depends on its stratum.

CASUALTY RATES

Casualty rates include both wounded-in-action and disease and nonbattle injury (DNBI) rates. As mentioned above, each zone and mission within the theater carries its unique set of casualty rates. Casualty rates are expressed in terms of hospital admissions per thousand troops per period of time.

Wounded-in-action (WIA) rates are generally derived from combat simulations performed by the military departments. Such simulations are informed by historical studies. WIA rates come not from the services' medical departments but from analytic organizations whose mission it is to address overall force planning assumptions. The rates used by each service have varied markedly over the years, producing variations in facilities requirements that have aroused challenges to their credibility.

Even in the relatively stable planning environment of the past two decades, WIA admission rates have been contentious.[9] The changing threat in Europe and the rising likelihood of combat in other theaters call for a thorough analysis as the services derive estimates of future WIA rates. A number of underlying factors, all more uncertain than in the recent past, influence WIA rates:

---

[9]For example, see D. B. Rice, *Defense Resource Management Study*, U.S. Government Printing Office, Washington, DC, February 1979, p. 93.

- Intensity of combat. More than any other factor, the overall intensity and nature of combat drives WIA rates. To the extent that DoD begins sizing U.S. forces on scenarios involving enemy forces that are less capable than those of the Warsaw Pact and less likely to engage in the intense warfare envisioned in Western Europe, planned WIA rates should be lowered. On the other hand, certain potential opponents might be capable of inflicting large numbers of casualties, particularly if they chose to use chemical or biological weapons.
- The lethality of weapons. Enhanced lethality of weapons can mean more casualties, but the proportion of casualties that dies may change as well. Hence, the relationship between battlefield lethality and the WIA rate is uncertain. The lethality of potential battlefields might roughly approximate the lethality of that facing NATO in recent years, but (as Desert Storm indicated) they may be far less lethal. To the extent that the combat force structure of U.S. forces begins to be sized to fight against forces *substantially* less lethal than the recent Warsaw Pact force, the resulting casualty rate may be expected to decline.
- The survivability of U.S. weapon platforms. New and more survivable tanks, armored fighting vehicles, aircraft, and ships are likely not only to reduce the number of U.S. casualties but to change the distribution of types of wounds as well.
- The force mix. The Army in particular is emphasizing light contingency forces as it withdraws from Europe and declines in strength. Infantry units experience different types of wounds than do armored units. Combat in other theaters probably means different geographic employment of support troops and, therefore, different risk of wounding than were planned for in the European theater. It is not clear what net effect these various changes will have on aggregate medical requirements.

Unlike WIA rates, which come from simulations and other sources external to the service medical departments, disease and nonbattle injury rates are developed by the medical departments. DNBI rates vary by theater due to climate, weather, endemic diseases, and the nature of operations. The services have relied heavily on historical rates, adjusting for such factors as advances in vaccines and other preventive measures. A range of uncertainty surrounds estimates of DNBI rates and

medical judgment is involved in their determination. For example, treatment protocols for stress and combat fatigue, which have varied over time, can affect the aggregate DNBI workload by increasing the number of servicemen diagnosed and treated for these conditions. Further, history demonstrates the power of commanders to affect DNBI rates through training and attention to the health practices and sanitation habits of their troops. Because DNBI rates can drive a substantial proportion of total medical resource requirements, they are currently being studied by the Logistics Management Institute in a DoD-sponsored effort. Regular review of these rates probably is warranted in light of the medical advances in the prevention and treatment of disease.

CONVERSION FACTORS

Aggregate WIA and DNBI rates can not be usefully translated into medical resource requirements without a specification of the distribution of diagnoses and the resources required to treat each diagnosis. For example, to permit predictions of requirements for surgical and medical specialists (such as neurosurgeons, thoracic surgeons, internists, and psychiatrists), WIA and DNBI admission rates must specify the frequencies among the WIA of head and chest wounds and among the DNBI of pancreatitis and schizophrenia. Then, medical experts must estimate the number of operating room hours, specialized equipment, personnel resources by specialty, and other resources required to treat the expected patient mix.

A quad-service panel has developed a clinical database[10] that contains assumptions as to the pathophysiological characteristics of the typical patient in each of 319 patient conditions, including wounds, diseases, and nonbattle injuries. For each condition, the document provides estimated lengths of stay at each echelon, and the medical, operative, nursing, and ancillary care required to treat each typical case. Medical planners now use the data for force planning. Nevertheless, this database requires ongoing systematic and documented review to ensure that it includes the most important wartime patient conditions and reflects current treatment technology.

The length of stay by patient condition represents another factor necessary for the conversion of casualty rates to resource requirements. Historical data are available from World War II, Korea, and Vietnam lengths of stay, but data in

[10]"DEPMEDS Policies/Guidelines Treatment Briefs," 21 November 1986, unpublished document.

peacetime settings have dropped significantly in recent years. It is not clear in the current documentation how regularly these data are updated according to changes in technology and accepted medical practice.

Another conversion factor, the dispersion factor, is a multiplier applied to derived requirements that is intended to compensate for the anticipated lumpiness of patient flows. Its proper determination should derive from estimates of the variance over time in the number, location, and mix of casualties and the concurrent availability of the deployed medical resources. Some, but not all, of the anticipated variance can be eliminated by speeding or slowing the evacuation of patients through the system and by the use of mobile teams of medical personnel, as now planned. There is fairly standard use of a dispersion factor of 1.25 for the combat zone; communications zone dispersion factors range from 1.05 to 1.25. Analysis of these factors might be fruitful, if only to validate and document their sources.

PATIENT RETENTION AND MOVEMENT POLICIES

Policies dealing with retention and movement of patients through the medical system are used in two ways: first as planning factors and then in actual operations as devices to regulate the flow of patients. We next discuss the use of these policies as planning factors. Their use as patient control devices is discussed later.

Four policies determine the length of time patients remain at each echelon of treatment:[11]

- Evacuation policy—a determination as to which patients are to be evacuated based upon estimates of the total length of time they are *expected* to be hospitalized. For example, a theater evacuation policy of 15 days means that the services plan to evacuate out of theater as soon as their condition permits all patients whose expected length of hospitalization exceeds 15 days.

[11]The theater medical system consists of four echelons of care:
- First echelon–self-aid, buddy care, or treatment by a corpsman or medic.
- Second echelon–battalion aid stations or battle dressing stations aboard ship. At this echelon, patients generally have their first encounter with a physician, physician's assistant, or independent duty corpsman.
- Third echelon–in-theater hospitals that resuscitate, conduct initial surgery, and conduct postoperative treatment.
- Fourth echelon–in-theater or other overseas hospitals equipped to provide definitive care and recuperation prior to evacuation or return to duty.

CONUS hospitals represent, in effect, a fifth echelon.

- Evacuation schedule—an estimate of the average delay between admission to a particular echelon and evacuation to a higher-echelon hospital. Evacuation schedules are diagnosis-specific; they are determined largely by the length of time required to stabilize patients before they can be transported safely to the next echelon.
- Skip percentage—the percentage of patients who are evacuated directly from the combat zone to areas outside the theater, including CONUS. Such patients generate no requirements for hospitals in the intermediate echelons.
- CONUS retention policy—the proportion of required care in CONUS that is provided in DoD facilities rather than through other hospitals such as those operated by the Department of Veterans Affairs or affiliated with the National Disaster Medical System.

Two of these policies, evacuation policy and the CONUS retention policy, share two important characteristics: (1) both are powerful determinants of resource requirements not only for medical resources but for airlift, engineer, and other non-medical resources as well, and (2) both lie outside the purview of medical planners alone to decide.

Evacuation Policy

Evacuation policy plays a preeminent role in determining active duty and reserve medical requirements and their likely positioning. As a planning tool, evacuation policy determines which patients are to be evacuated from a given echelon and which are to receive all their treatment at that echelon without evacuation. The longer the evacuation policy early in a conflict, the greater the active duty medical requirements in theater; the longer the policy later in the war, the greater the reserve medical requirements or requirements for conscripted manpower. Longer evacuation policies also increase the requirement for lift to deploy medical facilities to the theater but decrease the requirements for lift and medical personnel to evacuate patients.

Populations at risk and casualty rates are determined largely by the mission to be accomplished and the risk factors associated with the required force; they offer planners little policy discretion. Evacuation policy, in contrast, offers planners wide latitude as to the relative proportions of treatment provided in the theater of

operations and in CONUS. Evacuation policy figures prominently in lift or pre-positioning requirements for hospitals, personnel replacement requirements, active/reserve mix, and other resource issues.

Combat commanders have an incentive to seek long evacuation policies in planning scenarios. For example, a theater evacuation policy of 60 days will return substantially more of the theater commander's sick and injured to duty without evacuation to CONUS than will a theater evacuation policy of 30 days. The shorter the theater evacuation policy, the more patients are evacuated and the more replacements the theater commander will require to maintain a given fighting strength at a given period of time.

On the other hand, combat commanders must weigh the marginal benefits of a longer evacuation policy against its added costs, such as the airlift and sealift that must be diverted from other missions to deploy the extra hospitals associated with that longer evacuation policy. Further, just as hospitals are part of a logistics tail for the combat force, hospitals themselves require a personnel and logistics tail to support them. The size of the logistics tail in a theater is an important consideration to the theater commander. For very good reasons, then, evacuation policy is generally considered a line decision, not a medical decision.

During an actual combat operation, evacuation policy becomes a tool to regulate patient flows. Although the medical resources the theater commander has at his disposal have already been determined by the *planned* evacuation policy, he will adjust the *operational* evacuation policy as frequently as patient flows dictate. A theater commander may have on hand enough beds to accommodate a 30-day evacuation policy, based upon the *planned* populations at risk and casualty rates. But if deployment delays or unexpectedly low casualty rates result in fewer than expected casualties, the theater commander may raise his *operational* evacuation policy to 35 or 40 days to hold down the number of evacuees from the theater and to fully occupy his existing facilities. Similarly, just before an attack the commander may reduce his operational evacuation policy to make more hospital beds available in anticipation of unusually high casualty rates. Nevertheless, no patients are moved before their conditions permit.

It should be noted that over time, transportation technology has played a role in determining evacuation policy. During World War I, the theater evacuation policy varied but was often set as long as 150 days. By World War II, with better transportation systems, theater evacuation policies of 60 days were common. During

the Vietnam conflict, evacuation policies of 15 days were common. Today, if his condition permits, a casualty could in theory be lifted from his unit by helicopter, loaded onto an Air Force medical evacuation flight, and be in a CONUS hospital or other hospital out of theater in a matter of hours.[12]

Despite our impressive evacuation capabilities, medical and nonmedical planners alike argue against shortening evacuation policies on the grounds that to do so allows more troops to leave the theater, increasing the requirement for replacements. This concern stems in part from a historical policy precedent. In both World Wars, we planned not to return evacuated patients to the theater, for three very good reasons: (1) evacuation policies were so long that only the seriously sick or injured were evacuated and these patients required long recuperative times, (2) transportation technology prevented rapid return of patients returning to duty, so evacuation and return would have added substantial time to the patient's total nonavailability time, and (3) it was thought wrong to return wounded troops to combat when so many newly drafted soldiers and sailors had not yet made their sacrifice.

With relatively shorter evacuation policies today, with greatly enhanced transportation technology, and with scenarios that call for large numbers of troops quickly, it may be prudent to return many evacuated casualties to the theater once they have recovered. Further, to the extent that new sizing scenarios are set in geographic regions where there is little medical infrastructure compared to the extensive U.S. and host nation facilities in the NATO nations, shorter evacuation policies may be needed to clear those medical facilities available under a short deployment schedule.

Evacuation Schedule

Whereas evacuation policy predicts which patients are evacuated, the evacuation schedule estimates how long they remain at a particular echelon before they are moved. The evacuation schedule is determined by the time required for transportation to become available and the time required for patients to become ready for evacuation. During the 1980s, the Defense Guidance directed the services

[12]Throughout the 1980s, the theater operating plans (OPLANs) specified long evacuation policies (30 to 60 days) that far exceeded existing or programmed theater capabilities. Throughout the period, the Defense Guidance directed the services to procure the lesser capability (also far larger than programmed resources) required to support a 15-day policy at periods of peak hospital admissions.

to use at least a five-day schedule in predicting facilities requirements. Thus, it is assumed that patients are hospitalized in theater for an average of five days before they are evacuated to CONUS. A shorter schedule could be adopted, at some risk to the patients if it increased the probability of deploying insufficient medical resources, a longer one would be at some cost in acquisition of the medical facilities and lift required to support it. It is not clear that a smaller force or new sizing scenarios will in any way affect the planned evacuation schedule, which tends to stay relatively constant in any case. The evacuation schedule may be affected, however, by changes in the distribution of types of wounds and illnesses arising from the new scenarios.

CONUS Retention Policy

In any major conflict, hospital beds are required in CONUS to care for evacuated troops and CONUS-based troops who are sick and injured. The policy that sets the proportion of those patients to be treated in military as opposed to civilian facilities is termed the "CONUS retention policy." It represents an important policy variable because it affects large resource requirements and carries with it a high degree of policy latitude. In the extreme, all returning evacuees might be placed in non-DoD hospitals in the CONUS through arrangements with other systems. At the other end of the spectrum, DoD might decide to provide all such care in its own hospitals. In a large war the swing would be well over 100,000 beds. However, CONUS retention policy will have an important effect on active and reserve component peacetime structure only to the extent that non-DoD hospital alternatives can provide civilian medical personnel as well as beds in wartime. If civilian personnel are available to handle wartime casualties in non-DoD facilities, CONUS retention policy will affect active requirements in that not all active duty medical personnel deploy; some remain in CONUS to help staff the DoD CONUS facilities. It will affect reserve requirements more deeply in that CONUS hospitals are staffed primarily with reservists in wartime, at least initially.

The services currently plan on a 60-day retention policy in DoD facilities in the CONUS for both evacuees from combat theaters and patients admitted in the CONUS, and to retain all patients whose length of stay is expected to exceed 60 days for five days before transferring them to the National Disaster Medical System (NDMS) or the Department of Veterans Affairs (DVA). Recent scenarios involving a major war in Europe with a 60-day CONUS retention policy would require over 126,000 DoD hospital beds in the CONUS. The services currently operate about

14,000 beds, but they report that their hospitals could expand to provide about 34,300 beds. In addition, the Army, for example, reports that it could provide another 49,000 minimal-care beds in barracks, gymnasiums, classrooms, and the like. It is not at all clear, however, with over a million civilian hospital beds in the United States, that military hospitals need to expand to these levels, much less convert schools and gymnasiums.

With smaller populations at risk and with potentially less intense and lethal future battlefields, the number of patients returning to CONUS, even under a short evacuation policy, is likely to decline substantially. Perhaps the existing DVA beds and 100,000 NDMS beds would be able to accommodate the full additional CONUS workload, eliminating a large portion of the wartime requirement for CONUS beds.

A policy decision as to how much of the workload to keep in-house entails significant facilities and manpower issues and could have important implications for sizing the medical force. The manpower implications of relying on NDMS are unclear without more information about staffing. Some military manpower, perhaps in the individual ready reserve, may be needed to ensure that patients could in fact be transferred to NDMS beds upon evacuation from overseas hospitals. Other issues that would need to be addressed are administrative control over a potentially diverse CONUS wartime system and the risks associated with an ineffective mobilization of civilian resources.

IMPLICATIONS

As DoD reduces its forces and as sizing scenarios evolve, wartime medical requirements remain uncertain. Nonetheless, several conclusions may be drawn at this early juncture in the transition to a new force. Several key determinants of wartime medical requirements point toward substantially reduced requirements from those of the recent past:

- Smaller forces at risk will mean fewer casualties and, therefore, reduced bed requirements. As a result, fewer active and reserve hospitals will need to deploy.
- Less lethal battlefields may lower casualty rates. Again, fewer casualties imply a smaller requirement for active and reserve hospitals to deploy.
- Shorter evacuation policies in less mature theaters of operations could have the effect of transferring workload from the theater, although much of the

resource-intensive care needed for stabilizing patients would still be needed. To the extent that casualties may be treated in civilian rather than in military facilities, and by civilian personnel, the requirement for nondeploying medical structure, primarily in the reserve components, will be reduced.

Regardless of scenario changes and force reductions, DoD may be able to further reduce its wartime-required medical structure through policy changes to transfer more of its CONUS workload to the private sector by relying to a greater extent on DVA and NDMS hospitals and civilian personnel instead of expanding its own hospitals.

Together, scenario changes and expanded use of private sector options in CONUS could offer the Department savings in medical force structure. The exact size of the potential reduction requires a setting out of specific scenarios and follow-on analysis of casualty rates and patient evacuation and retention rates in particular. Further, any potential reductions resulting from smaller readiness requirements must be subject to force structure constraints posed by the benefit mission.

4. SIZING TO PROVIDE PEACETIME HEALTH CARE BENEFITS

The issue of who provides medical benefits to active and retired service members and their families is not decided on purely economic grounds. The military departments have a strong sense of responsibility to provide certain benefits to service members and their families in kind rather than in cash. Commissaries, exchanges, and family housing represent other ways the services live up to this responsibility, often referred to as "taking care of our own."

Under the law, dependents of active duty personnel, retirees, and their dependents are offered treatment in military facilities *only when space is available*. Space need not be made available solely to care for these beneficiaries. Large civilian employers provide most of their employees' medical care through health benefits plans that only finance the care, such as CHAMPUS and the Federal Employees' Health Benefits Plan, rather than through employer-operated health care facilities. While overseas it may be more difficult to rely on local health care providers, most installations in CONUS are located in areas where adequate health care is, or with the right incentives could be made to be, available. At issue is not whether sufficient civilian sources already exist today, but at what cost civilian health care providers would respond to the increased demand of a military population if the military system were smaller and whether the medical treatment facilities (MTFs) could provide the care at lower cost. An assessment of alternatives for providing the health care benefit must also recognize the common perception of service members that an implicit commitment has been made to provide direct care. Of special concern is the direct provision of health care for active duty families, whose care arrangements are disrupted by frequent moves and who must deal with service members' absences and work schedules.

COST OF PROVIDING MEDICAL TREATMENT IN-HOUSE

The services have long argued that it is inherently cost-effective to expand their minimum essential medical force to treat retirees and dependents who would otherwise get their care through CHAMPUS.[13] Analysis has shown that a given

[13]Some military beneficiaries also are covered by health care plans offered by civilian employers of working family members or by Medicare instead of CHAMPUS. If added MTF resources cause beneficiaries to shift from these programs, DoD costs increase.

medical service may be provided more efficiently in existing in-house hospitals and clinics than through CHAMPUS because the facilities necessary to provide such care are already paid for by the readiness mission.

Thus, for example, employing a military internist to see a CHAMPUS-eligible retiree for diabetes can be expected to be less costly because the hospital space, diagnostic equipment, and support staff used for the visit all are required in wartime. Indeed, the physician is likely to be required to treat the wide range of infectious and environmental diseases that can occur in a combat theater. Current costing methods include average manpower costs (including benefits but not the higher procurement costs for physicians or their special pays), most equipment depreciation, and operating expenses supported by the hospital's budget (but not by the base or other service budgets).

Adjusting these costs to include special manpower costs and costs borne by other budgets, as the Defense Manpower Data Center is now doing as part of its unit costing project, probably will make little difference. However, other considerations could change the conclusion. For example, if the retiree is covered by Medicare, the savings accrue to the Department of Health and Human Services instead of DoD. If he is insured through his civilian employer, the care would not be paid for by CHAMPUS and his care is costly to DoD unless it can collect from the other insurer.

So far, the discussion has concerned the relative costs of a single visit. However, a more appropriate measure is the cost of providing all the health care used by the retiree. Research has amply demonstrated that when health care is free, more visits will be made. As MTF resources increase, the beneficiaries' demand can be expected to expand because of their response to the greater availability of free care and the shift of some beneficiaries from non-DoD payors to the MTFs. The cost of treating an additional beneficiary includes the cost of the resulting expansion in the demand for DoD-sponsored care.

If wartime requirements were to decrease sufficiently to eliminate the need for at least some current hospitals as wartime treatment facilities or places to employ wartime-required personnel, the appropriate measure of the costs of MTF care would include facility depreciation. The question thus becomes: "What is the long-run marginal cost of shifting care between the direct care system and the most cost-effective alternative means of providing such care?" As we discussed, this broad question requires consideration of (1) full economic costs, such as construction and the often hidden costs of the support tail required by medical force structure, (2) the

cost of care that dependents and retirees now receive under other health care plans but that would shift to the direct care system if direct care were made more available, (3) differing utilization rates that result from differing cost-sharing provisions in the direct care system and alternative sources, such as CHAMPUS, health maintenance organizations, and private insurers, and (4) an adjustment for differences in case mix and case complexity currently being delivered in alternative systems. No analysis that meets the above criteria appears to exist.

Reforms of the military health care system currently being tested by DoD can be expected to alter these relative cost calculations. The "coordinated care" concept introduced this year by the Assistant Secretary of Defense for Health Affairs extends the recent trend toward blending military and civilian health care resources to provide health care benefits. Increasing numbers of civilian medical personnel are working in DoD's MTFs, many of them paid through CHAMPUS, and military personnel sometimes provide care in civilian hospitals. CHAMPUS is adding preferred provider organization and health maintenance organization options, in some cases using the same civilian providers in these new options to augment MTF resources. Finally, "managed" care approaches developed recently in the civilian sector are being adapted to channel patients to the most cost-effective military or civilian provider. Current costing methods are even more inadequate for this coordinated care system than they were for the relatively simpler dual MTF-CHAMPUS system.

Even if it can be shown that direct care is more cost-effective, it might still be in the best interest of DoD contract for civilian care or substitute civilian personnel for military personnel in the MTFs. Within a given military manpower ceiling, for example, the expansion of medical facilities requires the services to give up other force structure in order to retain more medical manpower. There are 155,000 military personnel on active duty in support of the medical function.[14] Therefore, a decision to rely less on active duty medical personnel to provide the military health care benefit could free up numerous manpower authorizations for other functions. DoD may legitimately decide to pay somewhat more for dependent and retiree health care in order to add combat or other necessary force structure within given end strengths. Therefore, given manpower ceilings, a full cost-benefit analysis requires

[14]U. S. Department of Defense, *Manpower Requirements Report, FY 1991*, Medical Manpower Annex, February 1990, p. 4.

comparison of the benefits of other force structures against the cost savings from using military instead of civilian resources to provide health care.

OTHER FACTORS TO BE CONSIDERED

Aside from cost, there are arguments both for and against the "contracting out" of health care in the CONUS. To the extent that we station military medical personnel overseas, we must provide hospitals and clinics for them to work in once they return to the United States. This is the so-called "rotation base" issue. In the future, however, as we withdraw troops and dependents from Europe and the Far East, the size of the overseas structure is likely to decline. There should be fewer service members and dependents overseas to treat and, therefore, less medical structure required overseas for the benefit mission. Fewer hospitals and clinics overseas imply a smaller rotation base in CONUS.

The new, more complex peacetime arrangements can also either aid or detract from the readiness mission. For example, reserve personnel may be easier to recruit for civilian peacetime positions in the MTFs or in civilian provider networks (or vice versa). In addition, they gain added exposure to the military health care system. However, as Desert Storm illustrates, the benefits of dual-role personnel must be balanced against the monetary and nonmonetary costs of disrupting family health care delivery during deployment.

GRADUATE MEDICAL EDUCATION

The law allows DoD to add medical structure to operate a sizeable Graduate Medical Education (GME) program. The military departments maintain GME programs because they believe that:

- The availability of high-quality specialty training helps attract physicians into the military. Military pay, even with the special and incentive pays military physicians earn, is not competitive with private earnings in most specialties. The lure of medical scholarships, supported by the opportunity to enter military GME programs, overcomes that inherent disincentive to military medicine.
- In-house residencies produce physicians who are more likely than those trained in civilian residencies to remain in the service after their obligated service. It is not clear, however, how much of the difference results from

self-selection; physicians who already have an affinity for the military may seek in-house residencies.

- It is consistent with the services' general notion of "taking care of our own." Teaching programs offer opportunities to provide care for a large number of beneficiaries, many of them with serious illness. The resulting large medical centers are believed to have the added benefit of providing this care at a low cost relative to alternatives, as discussed above.
- A final factor is the underlying belief—shared by all three military medical departments—that military medicine ought to be a full-spectrum enterprise, consisting of primary through tertiary care facilities. To sustain its quality, military medicine believes it must maintain state-of-the-art medical centers that practice a full range of medicine, train physicians, and conduct medical research. This is consistent in important ways with most other large hospital systems. The Department of Veterans' Affairs, Kaiser, Humana, and others all maintain some level of GME. Such training ensures credibility and quality in their systems and thus sets the standard for their operation.

But the commitment to teaching and research in the medical departments costs the services some manpower authorizations that could be devoted to other defense functions. This opportunity cost in manpower has become more acute as the current drawdown significantly lowers total manpower authorizations. The health care function represents a support function that can be accomplished, to some extent, by the civilian sector. Further, it may be cost-effective to shift certain types of care to the civilian sector. The 18 teaching centers provide a great deal of care; the potential costs or savings from shifting this care to civilian providers or military nonteaching medical centers are unknown. The costs of teaching in civilian hospitals, net of the costs attributable to the patient care provided by attending physicians and residents, are generally estimated to be small. However, operating GME in the military system affects the channeling of the most seriously ill patients to military rather than civilian facilities and may, therefore, generate more or less added costs than would be implied just by the addition of GME programs in a tertiary care hospital.

5. SIZING WITH BOTH MISSIONS IN MIND

To analyze the differing demands of the readiness and benefit missions independently, as was done in the previous two sections, can yield naive conclusions Although the process does offer a useful understanding of the requirements each mission generates and how those requirements change with their underlying planning factors, it does not provide practical solutions to the sizing problem. Practical solutions require an analysis that considers the interrelationships of the two missions.

It is impractical, for example, to build a wartime-required force without regard to how that force is to be employed in peacetime. Physicians and other providers need to maintain their skills through practice in some setting. Reserve physicians maintain their medical skills in their civilian practices. The obvious way to employ wartime-required active duty providers in peacetime is to have them treat military beneficiaries To do so allows DoD to use resources required for one mission to accomplish a second mission at very low added cost. But the calculus is not straightforward; the amount and mix of resources necessary to meet the wartime mission differ from that required to accomplish the peacetime mission. Both the intersections of the missions and their divergences are multifaceted and include some aspects that may not be quantifiable.

The problem is one of joint production of readiness and peacetime health care using the same active component resources. Some resources are more productive in one mission than the other and some are equally productive in both. Alternatives exist to active component resources in both missions, but the alternatives' productivities (i.e., capability) and costs relative to active resources vary. Reservists can substitute for active personnel in the wartime mission but their availability for rapid deployment and their military-specific knowledge may be lower. In addition, they provide little, if any, peacetime health care to military beneficiaries in their role as reservists. The civilian alternatives discussed earlier are useful only for the care of casualties evacuated to CONUS, unless they are drafted into active service, and they provide no peacetime care without additional payment. With respect to the benefit mission, the alternative to direct care is CHAMPUS in its standard or reformed versions. CHAMPUS is generally thought to be more expensive, but a full

accounting of marginal long-term costs could render CHAMPUS less costly for at least some services. CHAMPUS contributes nothing to the readiness mission.

To determine the optimal size of the direct care system (i.e., level of active component resources) requires simultaneous analysis of both missions. A formal framework for such an analysis, using mathematical programming tools, was developed in an earlier RAND study for the Air Force.[15] The framework is not complete—for example, it does not treat GME and only indirectly considers the reserve forces—but it represents the kind of approach needed to deal with the complex issues surrounding the sizing of the military medical system. It determines the "best" active duty physician force given the joint goals of maximizing wartime treatment capability and minimizing the overall cost of providing peacetime health care benefits. The framework could be modified to deal with the current goals of meeting the new wartime requirement and providing the military health care benefit at lowest overall cost in terms of active duty and reserve forces, CHAMPUS or other similar programs, and the administrative costs of maintaining a standby civilian system desirable for treating wartime evacuees. GME would have to be treated separately, but in parallel with the overall sizing analysis.

The real challenge is to develop the extensive data needed for the framework to be useful. For the readiness mission, these data would describe future wartime requirements, limits on the ability of the various alternatives (active, reserve, civilian) to meet those requirements, costs of the wartime alternatives. To determine the wartime requirement requires a reassessment of all the factors we discussed above, but especially casualty rates and evacuation policy. Retention policy is treated directly in the model by incorporating civilian treatment as a (limited) alternative for evacuees. For the benefits mission, the data must be defined by the most important beneficiary categories and include the number of beneficiaries (or beneficiary equivalents) whose health care can be provided by a military provider in each specialty, the costs of military providers, and the cost per beneficiary treated under the most cost-effective design for CHAMPUS.

---

[15]J. Buchanan, and S. Hosek, *A Methodology for Evaluating Air Force Physicians' Peacetime and Wartime Capabilities*, RAND, N-1990-AF, July 1983. See also S. Hosek, J. Buchanan, and G. Goldberg, *Reconciling Air Force Physicians' Peacetime and Wartime Capabilities: Demonstration of a Workforce Design Methodology*, RAND, R-3202-AF, August 1985, for a less formal presentation of the model and application of a limited version of the model.